



Energy & Environmental Research Center

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January 28, 2021

Ms. Karlene Fine  
Executive Director  
North Dakota Industrial Commission  
State Capitol, 10th Floor  
600 East Boulevard Avenue  
Bismarck, ND 58505-0310


Dear Ms. Fine:

Subject: Quarterly Progress Report Entitled "Research in Support of Integrated Carbon Capture and Storage for North Dakota Ethanol Production"; Contract No. R-043-053  
EERC Fund 25204

Attached is the subject report for the period of October 1, 2020, through December 31, 2020, that shows the progress that has been made with partners of this project.

Thank you for funding this work. If you have any questions, please contact me by phone at (701) 777-5013 or by e-mail at kleroux@undeerc.org.

Sincerely,

DocuSigned by:  
  
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Kerryanne M. Leroux  
Principal Engineer, Subsurface R&D

KML/kal

Attachment

c/att: Andrea Holl Pfennig, NDIC



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# **RESEARCH IN SUPPORT OF INTEGRATED CARBON CAPTURE AND STORAGE FOR NORTH DAKOTA ETHANOL PRODUCTION**

Quarterly Progress Report

*(for the period of October 1, 2020, through December 31, 2020)*

*Prepared for:*

Karlene Fine

North Dakota Industrial Commission  
State Capitol, 14th Floor  
600 East Boulevard Avenue, Department 405  
Bismarck, ND 58505-0840

Project Period: June 1, 2020 – November 30, 2021  
Contract No. R-043-053

*Prepared by:*

Kerryanne M. Leroux

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January 2021

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## **RESEARCH IN SUPPORT OF INTEGRATED CARBON CAPTURE AND STORAGE FOR NORTH DAKOTA ETHANOL PRODUCTION**

### **EXECUTIVE SUMMARY**

The Energy & Environmental Research Center (EERC) at the University of North Dakota (UND), in partnership with the North Dakota Industrial Commission (NDIC) and North Dakota ethanol producer Red Trail Energy (RTE), is conducting the fourth phase (Phase 4) of a multiphase research and development effort to create the first integrated carbon capture and storage (CCS) system in North Dakota for the reduction of carbon emissions from ethanol production and capitalize on evolving low-carbon fuel (LCF) markets. The ultimate goal of this effort is implementation of a small-scale (<200,000 metric tons, or tonnes, CO<sub>2</sub> per year) commercial CCS system at an industrial fuel production facility to generate a reduced-carbon ethanol fuel applicable for LCF programs. Actions this quarter toward supporting continuation of the CCS effort at the RTE site include the following:

- Completed Milestone 2 (M2) – Laboratory Analyses Complete
- Completed geologic evaluation: Results support interpretation that adequate injectivity, capacity, and containment are present to implement the RTE CCS project and that sufficient data/information are available to complete a North Dakota CO<sub>2</sub> storage facility permit (SFP) application.
- Completed draft geologic exhibits and area of review (AOR) portions of a North Dakota CO<sub>2</sub> SFP application as detailed in North Dakota Administrative Code §43-05-01, which the North Dakota Department of Mineral Resources (DMR) will review for compliance; ultimately, the information will be integrated into Deliverable (D) 1, CO<sub>2</sub> Storage Characterization Methodologies Report.
- Completed drafts of the Supporting Permit Plans and the Injection Well and Storage Operations portions of a ND CO<sub>2</sub> SFP application, to also be provided for comment to the North Dakota DMR for compliance and ultimately integrated into D3, CO<sub>2</sub> Storage Facility Permitting Guidance Document.
- Next quarter, outlines for the D1 and D3 documents will be drafted following receipt of North Dakota DMR comments. Preparations for execution of remaining outreach activity plans will also be conducted. The Section 45Q final regulation submitted for publication to the Federal Register in January 2021 is being reviewed, and discussions will commence with California LCFS (Low-Carbon Fuel Standard) staff to detail additional needs beyond North Dakota CO<sub>2</sub> SFP requirements for LCFS CCS permanence certification.

The EERC holds an unwavering commitment to the health and well-being of its employees, partners and clients, and the global community. As such, precautionary measures have been implemented in response to COVID-19. Staff continue to carry out project-related

activities remotely, and personnel supporting essential on-site laboratory and testing activities are proceeding under firm safety guidelines. Travel has been minimized, and protective measures are being undertaken for those who are required to travel. At this time, work conducted by EERC employees is progressing with minimal disruption. Challenges posed by economic variability will be met with open discussion between the EERC and project partners to identify solutions. The EERC is monitoring developments across the nation and abroad to minimize risks, achieve project goals, and ensure the success of our partners and clients. In the event that any potential impacts to reporting, scope of work, schedule or cost are identified, they will be discussed and addressed in cooperation with the project partners.

## **RESEARCH IN SUPPORT OF INTEGRATED CARBON CAPTURE AND STORAGE FOR NORTH DAKOTA ETHANOL PRODUCTION**

### **ACCOMPLISHMENTS**

#### **Major Goals of the Project**

The ultimate goal of this effort is implementation of a small-scale (<200,000 tonnes CO<sub>2</sub> per year) commercial carbon capture and storage (CCS) system at an industrial fuel production facility to generate a reduced-carbon ethanol fuel applicable for low-carbon fuel (LCF) programs. To achieve that goal, the Energy & Environmental Research Center (EERC), in partnership with the North Dakota Industrial Commission (NDIC) and Red Trail Energy (RTE), is conducting the fourth phase (Phase 4) of a multiphase research and development effort to create the first integrated CCS system in North Dakota for the reduction of carbon emissions from ethanol production and capitalize on evolving LCF markets.

#### **Accomplishments under These Goals (for the reporting period)**

In summary, Phase 4 will collect the data necessary to advance the RTE case study for ultimate implementation of the first integrated ethanol and CCS facility in North Dakota. This research and complementary RTE activities will advance the CCS effort toward a financial investment decision on commercial implementation. The expected results of this supporting research will, therefore, ensure secure injection and storage economic viability, regulatory compliance, public knowledge sharing, and generation of a North Dakota Class VI blueprint to effectively assist implementation of CCS by other North Dakota renewable energy or biofuel producers.

Specific research objectives for this subtask are to generate 1) a summary of site-specific geologic evaluation steps necessary to finalize CCS designs that ensure safe injection and storage; 2) contrasts—comparisons of federal and other state-level incentive requirements with the North Dakota Class VI Program, to establish potential business cases and ensure economic viability; 3) detailed interpretations and documentation needs to ensure regulatory compliance for CO<sub>2</sub> injection and storage; 4) community engagement and information dissemination, assessing impact, to ensure public knowledge sharing; and 5) documentation of pertinent outcomes to generate a North Dakota Class VI blueprint, to effectively assist implementation of CCS by other North Dakota renewable energy or biofuel producers.

#### ***Task 1.0 – Geologic Characterization and Evaluation***

This task comprises the remaining research activities needed to conduct an in-depth investigation of the geology of the RTE site, necessary for the preparation of a compliant North Dakota carbon storage permit package (Task 4). Data and samples have been collected from a stratigraphic test well drilled at the RTE CCS site (RTE-10) in March 2020. This activity includes laboratory analyses of collected geologic core samples (e.g., petrophysical, geomechanical, etc.), laboratory analyses of collected reservoir fluid samples (e.g., chemistry,

salinity, etc.), and data processing of collected downhole geophysical logging and formation testing results (e.g., dipole sonic, pulsed-neutron logging, etc.). Results of these activities will also provide necessary inputs for Tasks 2–4. The process of data needs identification, subsequent collection, and logistics associated with these activities will be detailed in Deliverable 1 (D1), CO<sub>2</sub> Storage Characterization Methodologies Report, as a guide to other biofuel producers.

Significant accomplishments for Task 1.0 during the reporting period include the following:

- Completed M2 – Laboratory Analyses Complete
  - Analyses of collected geologic core samples from the RTE-10 stratigraphic test well were conducted by the EERC in June – December 2020.
  - Geologic analyses conducted and how they satisfy the North Dakota CO<sub>2</sub> storage facility permit (SFP) requirements are shown in Table 1; Figure 1 shows prepared samples from the formations tested, i.e., the target injection/storage reservoir, as well as over- and underlying seals.
  - Reservoir fluid samples from the Inyan Kara and Broom Creek Formations were also analyzed by the EERC for anions, cations, metals, and salinity.
- Completed geologic evaluation: Results support interpretation that adequate injectivity, capacity, and containment are present to implement the RTE CCS project and that sufficient data/information are available to complete a North Dakota CO<sub>2</sub> SFP application.
- Completed draft geologic exhibits of a North Dakota CO<sub>2</sub> SFP application as detailed in North Dakota Administrative Code (NDAC) §43-05-01, which will be reviewed by the North Dakota Department of Mineral Resources (DMR) for compliance and, ultimately, integrated in the D1 report.
  - Geologic exhibits include required discussion of 1) data and information sources; 2) storage reservoir; 3) confining zones; 4) faults, fractures, and seismic activity; and 5) potential mineral zones.



**Table 1. Laboratory Analyses Performed on Collected Geologic Core from the RTE-10 Stratigraphic Test Well to Meet North Dakota CO<sub>2</sub> SFP Requirements**

Permit Requirements:	Mineralogy	Porosity	Permeability	Capillary Pressure	Geomechanics	Geochemistry	Model Input	CO <sub>2</sub> Mobility	Required Descriptions
<i>Completed Core Analyses</i>	<i>Direct Data Needs</i>			<i>Indirect Data Needs</i>					
Air Permeability			✓			✓			
Capillary Pressure		✓	✓	✓					
CO <sub>2</sub> /Brine Relative Permeability								✓	✓
CO <sub>2</sub> Entry Pressure								✓	✓
Contact Angle				✓		✓			
Porosity		✓					✓		
Scanning Electron Microscopy (SEM) Morphology	✓					✓			✓
Thin-Section Description/ Photography	✓								✓
X-Ray Diffraction (XRD)	✓					✓			
X-Ray Fluorescence (XRF)	✓					✓			
Geomechanical Testing					✓				



Figure 1. Opeche, Broom Creek, and Amsden Formation plugs from RTE-10 core, shown in preparation for laboratory analyses.

### ***Task 2.0 – Modeling and Simulation***

Task 1 results are being used to update geologic interpretations of the target CO<sub>2</sub> storage reservoir and seal(s) as well as refine injection designs and CO<sub>2</sub> plume predictions essential for permitting. Industry-standard software packages are being used in the updates of previous geologic models of the study area and development of new CO<sub>2</sub> injection simulation cases. If needed, revisions will also be made to capture and transport infrastructure designs to accommodate finalized injection designs. The processes by which data are integrated into geologic models and used to develop predictions of plume behavior will also be described in D1.

Significant accomplishments for Task 2.0 during the reporting period include the following.

- Updated geologic model and CO<sub>2</sub> storage simulations for the potential RTE CCS project, incorporating geologic site data, analysis results, and interpretation available to date.
- Geochemical simulations were conducted to evaluate chemical compatibility between potentially injected CO<sub>2</sub>, native brine, and rock lithology; no significant adverse impacts are predicted, as required by North Dakota CO<sub>2</sub> SFP (Table 1) and included in the geologic exhibits.
- Completed static geologic model and simulations and generated maps for area of review (AOR) determination.
- Completed draft AOR portion of a North Dakota CO<sub>2</sub> SFP application, which will be reviewed by the North Dakota DMR for compliance and, ultimately, integrated in the D1 report.
  - AOR discussion includes 1) AOR delineation, 2) corrective action evaluation, and 3) protection of underground sources of drinking water, as required by the North Dakota CO<sub>2</sub> SFP.

### ***Task 3.0 – Business Case Analysis***

LCF programs and other CCS incentives (e.g., Section 45Q) continue to be assessed to develop a business case analysis of North Dakota ethanol CCS commercial application. This task includes investigations of business cases implementing requirements from various LCF/incentive programs into North Dakota carbon storage permits to establish synergistic relationships between multiple oversight authorities at state and federal levels. This integration will allow North Dakota to provide verification for other oversight authorities through North Dakota's established permitting and oversight process. Analysis of these synergies will include a "crosswalk," or contrast-comparison, of the various programs and recommendations for leveraging symbiotic opportunities while also ensuring full compliance (D2, CCS Business Crosswalk).

Significant accomplishments for Task 3.0 during the reporting period include the following:

- California LCF Standard (LCFS) staff will only consider new ethanol–CCS design-based pathway (DBP) applications if significantly different from RTE’s process or if explicitly needed by investors, as they have deemed RTE’s accepted DBP application as the benchmark model for estimating carbon intensity values for ethanol–CCS.

#### ***Task 4.0 – Carbon Storage Permitting***

Final documentation is being prepared to satisfy a North Dakota CO<sub>2</sub> SFP as detailed in NDAC §43-05-01. The North Dakota permit covers multiple design aspects developed to ensure safe and effective site assessments, carbon storage operations, and postinjection monitoring. The draft documents initiated to satisfy the CO<sub>2</sub> SFP application are being finalized with the proposed characterization results from Task 1 and reviewed with North Dakota DMR such that RTE may submit for approval to start final CCS implementation (D3, CO<sub>2</sub> Storage Facility Permitting Guidance Document).

Significant accomplishments for Task 4.0 during the reporting period include the following:

- Completed draft templates for the remaining sections of a North Dakota CO<sub>2</sub> SFP application including Supporting Permit Plans and the Injection Well and Storage Operations sections, to also be provided for comment to the North Dakota DMR for compliance and, ultimately, integrated into the D3 document.
  - Supporting Permit Plans include required discussion of 1) an emergency and remedial response plan, 2) financial assurance demonstration, 3) worker safety plan, 4) testing and monitoring plan, 5) well casing and cementing program, 6) plugging plan, and 7) postinjection site and facility closure plan.
  - Injection Well and Storage Operations include required discussion of 1) the RTE-10 well proposed operational parameters, 2) the RTE-10 well proposed completion procedure to conduct injection operations, and 3) the RTE-10.2 well proposed procedure for monitoring well operations.

#### ***Task 5.0 – CCS Community Outreach***

The EERC continues to support local RTE efforts for public acceptance of North Dakota CCS targeted to landowners, Richardton and adjacent communities, city/county commissions, and regional educators. Areas of focus include stakeholder engagement activities in support of research and fieldwork, production and dissemination of informational materials, community outreach, implementation of a system to track engagement activities and acquire feedback, and ongoing assessment of progress. Building on the outreach experience and materials from 2019 activities, the project team is developing additional outreach materials and media and updating the project Web pages hosted on the EERC’s Plains CO<sub>2</sub> Reduction (PCOR) Partnership website. The experience and materials developed will be incorporated into D4, CCS Outreach Tool Kit.

Significant accomplishments for Task 5.0 during the reporting period include the following:

- Continued honing options for community open houses and in-person update meetings, considering evolving COVID recommendations:
  - Informational factsheets on the 1) North Dakota CO<sub>2</sub> SFP requirements and 2) capture of CO<sub>2</sub> from ethanol processing.
  - A series of up to five topical media releases focused on the RTE CCS project.
  - An informational video focused on the geologic characterization and evaluation process.
  - A virtual Q&A forum targeting the Richardton community and nearby landowners.

### ***Task 6.0 – Management and Reporting***

This task includes managing project activities and ensuring coordination and planning of the project with participants and sponsors.

Significant accomplishments for Task 6.0 management during the reporting period include the following:

- Engaged an advisory team of subject matter experts to evaluate and ensure technical compliance with materials generated for the D1 and D3 documents, prior to North Dakota DMR submission for comment. The team included a wide range of expertise including:
  - Petroleum engineer with reservoir engineering/simulation experience.
  - Regulatory oversight or compliance experience.
  - Geologist with geologic modeling and CCS experience.
  - Monitoring techniques and project development experience.
  - Client representative(s).

### **Plan for the Next Reporting Period to Accomplish the Goals**

All activities will continue progressing toward project goals. Detailed outlines for the D1 and D3 documents will be drafted following receipt of North Dakota DMR comments. Preparations for execution of outreach activity plans will be conducted. The Section 45Q final regulation submitted for publication to the Federal Register in January 2021 is being reviewed for possible implications to North Dakota CCS projects. Discussions will commence with California LCFS staff to detail additional needs beyond North Dakota CO<sub>2</sub> SFP requirements for LCFS CCS permanence certification.

## **PRODUCTS**

### **Publications, Conference Papers, and Presentations**

None.

**Web Site(s) or Other Internet Site(s), Technologies or Techniques, Inventions, Patent Applications, and/or Licenses**

None.

**CHANGES/PROBLEMS**

As mentioned previously in the Task 5 discussion, in consideration of evolving COVID recommendations, the EERC and RTE are developing alternative approaches to the in-person outreach activities. Examples under consideration include but are not limited to informational videos, virtual question and answer forums, and a series of media/materials releases.

The EERC is operational and open for business. Personnel that are not essential for on-site operations have transitioned to working from home. Essential project, laboratory, and field-based activities are proceeding with the incorporation of the Centers for Disease Control and Prevention (CDC), the state of North Dakota, and University of North Dakota guidelines associated with COVID-19, and mitigation measures have been implemented.

In collaboration with project partners, the EERC is continually assessing potential impacts to project activities resulting from COVID-19 and/or the U.S. economic situation.